Standex DETECT Electronics

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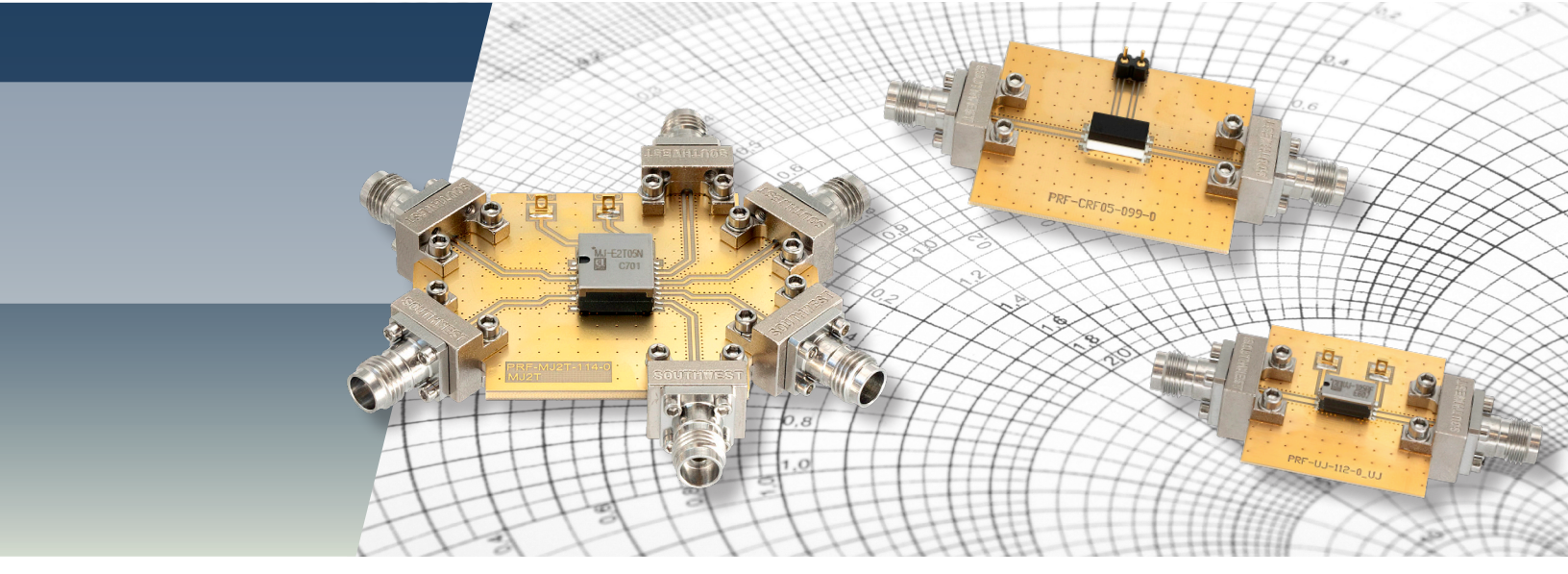
RF Board Engineering Guide

Evaluating Reed Relays in RF Test Systems



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RF Switching Starts with the Signal Path

Relays Are Part of the Signal Path — Not Standalone Components

System Performance Is Influenced by Every Transition

In semiconductor ATE, RF instrumentation, and high-speed validation systems, signal integrity is influenced by every element in the path, including:

- PCB routing
- Connector transitions
- Ground structures
- Relay insertion points

Relays directly affect:

- Insertion loss (signal attenuation)
- Return loss (impedance mismatch and reflections)
- Isolation (signal leakage and crosstalk)

Why Reed Relays Are Used in RF Applications

Reed relays are well suited for RF switching because their internal structure approximates a coaxial transmission line, which:

- Supports impedance continuity
- Minimizes parasitic capacitance
- Enables operation into the GHz range

However, these benefits only hold when the relay is properly integrated into the surrounding system.

The Core Challenge: Datasheet vs. Real System Behavior

Datasheet specifications represent isolated, controlled measurements.

In real systems, performance is often dominated by:

- PCB layout discontinuities
- Connector mismatches
- Parasitic effects from surrounding structures

As a result, system-level behavior can differ significantly from datasheet expectations.

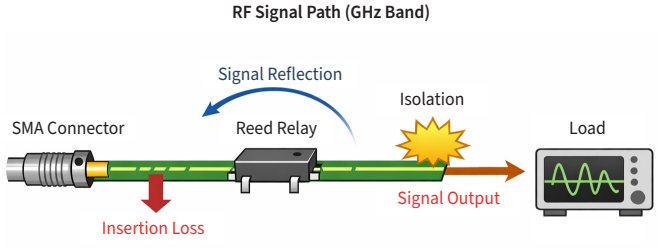


Figure 1. The relay must be evaluated as part of the complete RF signal path, not as a standalone component.

Why RF Evaluation Boards Matter

The RF evaluation board is designed to directly address this question.

In many RF designs, relay evaluation is performed using early prototypes or partial system configurations. However, this approach introduces numerous uncontrolled variables, making it difficult to interpret measurement results. As a result, it can lead to incorrect conclusions and unnecessary redesign.

Reference Board	Relay Board
Direct trace	Same trace **+ relay**
Same connectors	Same connectors
Same electrical length	Same electrical length

The evaluation board provides a controlled and reproducible environment. By standardizing the signal path, connectors, and layout, it enables evaluation focused specifically on the intrinsic effects of the relay.

By comparing the measurement results of both boards, the relay's contribution can be separated from the rest of the system. This differential evaluation reduces uncertainty and clarifies the actual impact of the relay on signal integrity.

This is not just a matter of convenience. It is fundamental to valid RF evaluation.

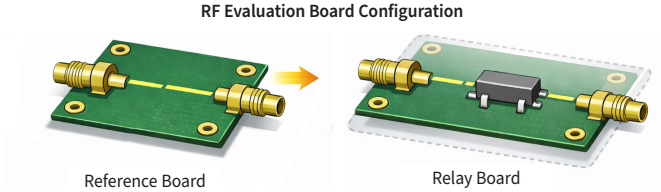
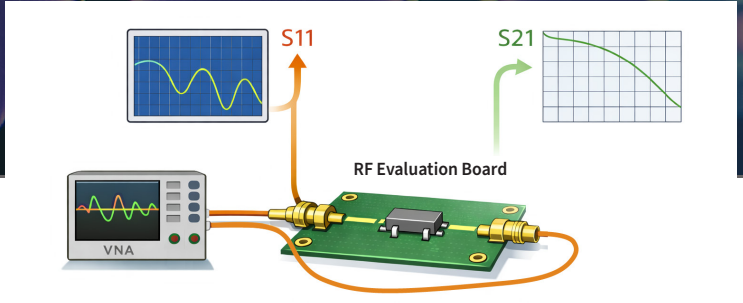


Figure 2. Differential measurement isolates the relay's RF contribution by holding all other variables constant.

Turning Measurements into Meaningful Insight

The Value Lies in Interpretation



The evaluation process is straightforward, but the value lies in how the data is interpreted.

A vector network analyzer (VNA) measures key RF parameters such as insertion loss, return loss, and isolation, derived from S-parameters that describe signal behavior in a two-port network. In this setup, the relay is treated as part of the network.

Accurate results depend on establishing a reference. A reference board defines the baseline signal path, enabling comparison with the relay board under identical conditions to isolate the relay's true RF characteristics. Without this reference, results cannot be reliably interpreted, especially at high frequencies, where PCB layout, connector transitions, and cable quality can dominate performance.

With a proper reference, measurements become meaningful, enabling quantitative analysis of insertion loss variation, return loss from impedance mismatch, and isolation when the relay is open. This transforms RF evaluation from trial-and-error into a repeatable, structured process.

VNA Measurement | S-Parameters | Reference Board Baseline | Relay Board Measurement | Delta = Relay Contribution

What Matters in Real Applications

RF parameters are most useful when connected to actual system behavior.

Insertion loss reduces signal amplitude, affecting eye diagrams and timing in high-speed testing, and limiting dynamic range and accuracy in RF measurements.

Return loss indicates impedance continuity along the signal path. Poor matching causes reflections, leading to increased settling time and measurement instability.

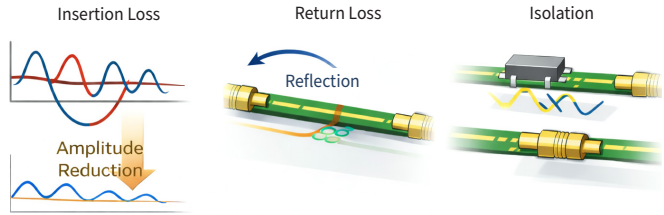
Isolation defines signal separation performance when the relay is open. In high-density switching matrices, insufficient isolation causes leakage and crosstalk, significantly degrading measurement results.

RF Parameter	What it Affects in Practice
Insertion loss	Amplitude, eye opening, dynamic range
Return loss	Reflections, settling time, stability
Isolation	Leakage, crosstalk, matrix accuracy

In the high-frequency domain, these characteristics are strongly influenced by parasitic elements. As reed switches are miniaturized, capacitance is reduced and RF performance improves; however, in practice, surrounding layout often becomes the dominant factor.

Therefore, even when using the same relay, system performance can vary significantly depending on the configuration.

Evaluation boards make these interactions visible early in the design process. They allow separation of relay-intrinsic limitations from system design constraints, making it possible to evaluate performance prior to final product integration.



How RF Demo Boards Support Real Test Systems

Across these applications, the evaluation board serves the same purpose: it provides a known, reproducible environment for evaluating the relay as part of the signal path.

Semiconductor ATE

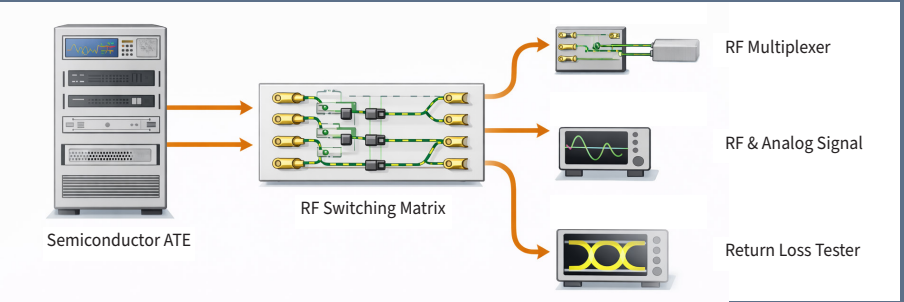
- Verify signal paths before matrix integration
- Confirm signal integrity across the required GHz range
- Compare relay impact against the reference board

Mixed-Signal Systems

- Identify switching-induced leakage or interference
- Validate RF and analog signal coexistence
- Support cleaner routing decisions before final PCB design

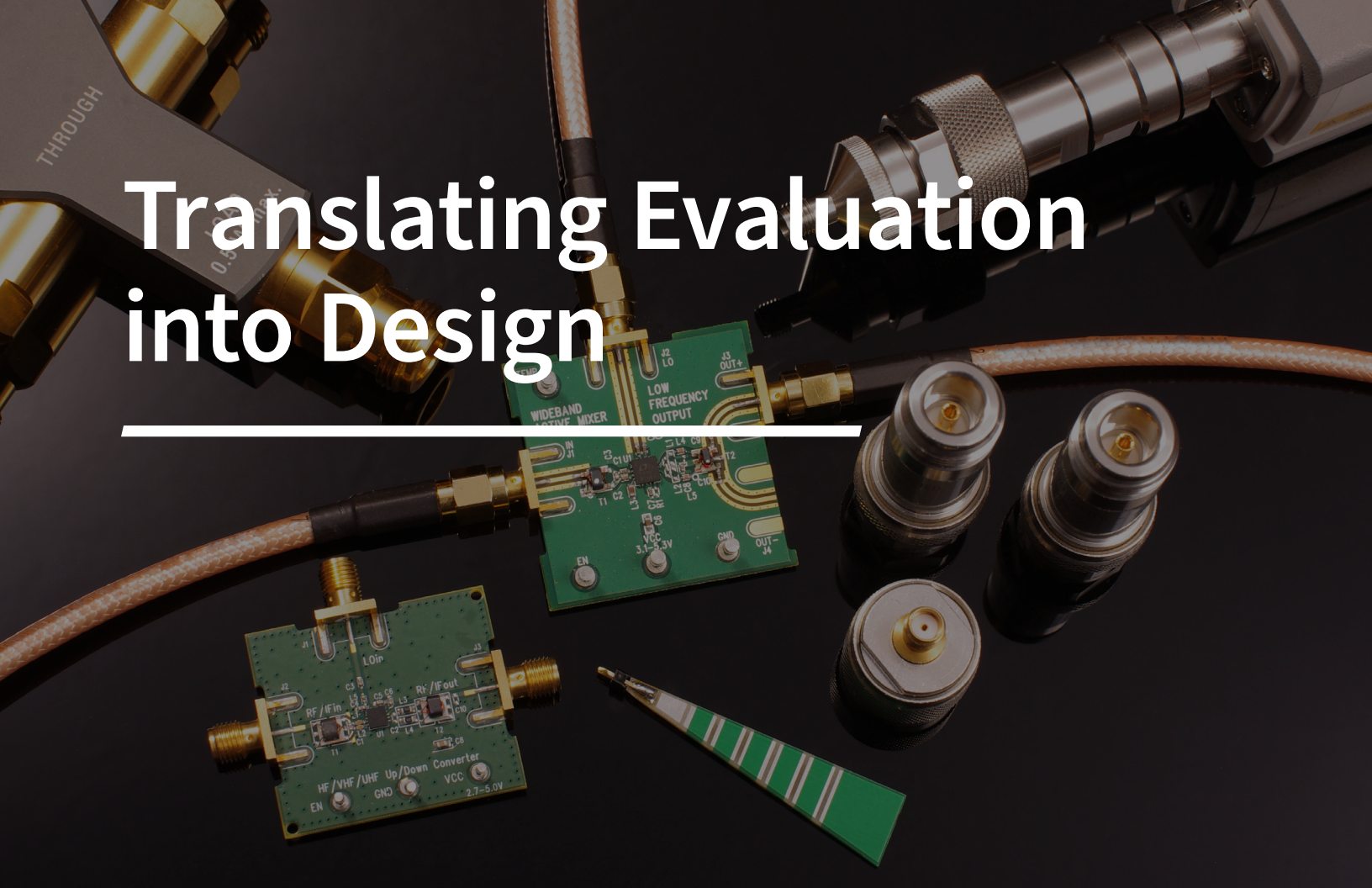
High-Speed Digital Testing

- Preserve fast-edge signal integrity
- Check eye opening and timing margin
- Evaluate relay behavior with fast rise-time signals



RF Multiplexers

- Enable multiple relay candidates to be compared under identical conditions
- Allows quantitative assessment of trade-offs among bandwidth, isolation, and mounting density



Translating Evaluation into Design

Once relay behavior is understood, the next step is integration into the final system.

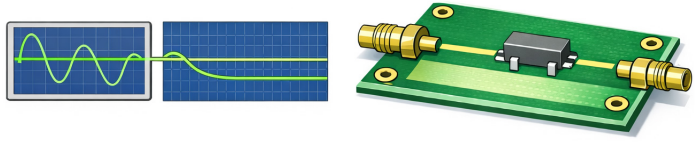
At this stage, fundamental RF design elements become critical. Impedance-matched routing, minimization of signal path length, and consistent ground design are essential to preserve the characteristics obtained during evaluation.

In high-frequency regions, even slight layout differences can significantly impact performance. Poor connector transition and impedance discontinuities can cause losses and reflections exceeding those of the relay itself.
The evaluation board serves as a reference implementation. It represents a configuration with verified reproducibility, and the closer the final design is to this, the higher the reliability of the results.

This helps reduce downstream rework, cost, and schedule risk.

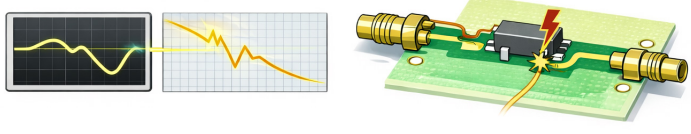
Good Layout

- Controlled 50 Ω impedance
- Consistent grounding



Bad Layout

- Impedance discontinuity
- Poor connector transition
- Ground discontinuity



START A CONVERSATION

Engineering Support as Part of the Solution

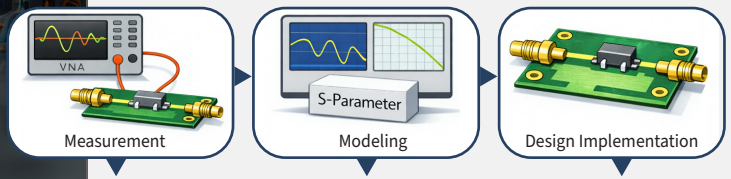
Evaluation boards
Measurement guidance
Engineering expertise

RF evaluation is not only a hardware challenge. It also requires knowing how to use the measurement data effectively.

Standex Detect supports this process by combining evaluation boards, measurement guidance, and engineering expertise. S-parameters are available for simulation and correlation, enabling engineers to model relay behavior before physical implementation.

The goal is not simply to collect data, but to provide actionable data that supports design decisions.

By integrating measurement, modeling, and real-world evaluation, the number of iterations can be reduced while improving design accuracy, resulting in more efficient development.

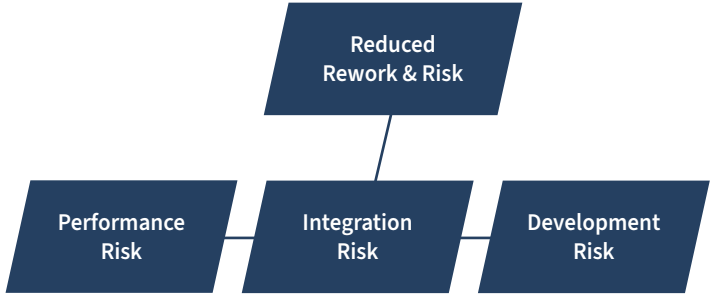


Integrating measurement, modeling, and practical evaluation to design with confidence

A Practical Path to Lower Risk

The RF evaluation board serves as a practical starting point for relay selection.

It accelerates the transition from theoretical specifications to measured performance and reduces uncertainty by isolating the relay's contribution from the overall system. Furthermore, it provides a foundation for evidence-based design decisions and reduced rework and risk.



Why Standex Detect

Standex Detect supports this closed-loop approach with RF evaluation boards, S-parameters, and engineering guidance.

RF switching is not only about selecting components that meet specifications. The key is understanding how the component behaves within the actual signal path.

RF evaluation boards provide a practical way to measure and compare this behavior. They support accurate measurement, direct comparison, and confident design decisions, helping customers integrate RF reed relays faster and with less risk.

Standex Detect extends this approach by supplying evaluation boards and S-parameters for simulation and correlation. This allows measured data to flow directly into design and modeling workflows, helping translate relay performance into reliable system-level results.

A Standex **Electronics** Business

The modern world pulses with silent signals that activate, safeguard, and synchronize the systems that underpin everyday life. As automation, renewable energy, transportation, and smart environments evolve into autonomous, adaptive networks, everything begins with one capability: the power to **Detect** what's next.

Standex Electronics delivers the high-performance sensing and switching solutions that enable this future. Through customer intimacy and deep technical collaboration, we listen, design, refine, and deliver solutions built for unwavering reliability.

Our expertise in reed switches, sensors, and relays enables equipment to sense position, measure speed, **Detect** presence, ensure safety, and control power with precision. We're advancing Detection at the speed of innovation for when it matters. Delivering the right design, at the right time, at the optimal cost.

Tomorrow's breakthroughs depend on our ability to Detect instantly, quietly, and reliably.

Welcome to **Standex Detect**.

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